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The Raven Small Unmanned Aerial Vehicle (SUAV), investigating potential dichotomies between doctrine and practice

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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

MBA PROFESSIONAL REPORT

The Raven Small Unmanned Aerial Vehicle (SUAV), Investigating Potential Dichotomies Between Doctrine and Practice

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June 2005

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13. ABSTRACT (maximum 200 words)

The goal of this MBA Project is to investigate possible disconnects between doctrine and practice in the employment of the Raven Small Unmanned Aerial Vehicle (SUAV). The Army's current Small UAV requirements are based upon the Future Combat System's Operations Requirements Document and has not been validated at the platoon or company level. The Raven SUAV is a Commercial off the Shelf (COTS) item that swiftly became the Army's Small UAV of choice for operations in Afghanistan and Iraq. Doctrine and Techniques, Tactics, and Procedures (TTP) have been written for the Raven SUAV; however, it is not standard practice for all units operating the system abroad. The last review of the SUAV operational requirements was conducted in 2003 but did not specifically address its usage on the battlefield. In an attempt to fill that gap, this project focuses on real-world usage of the Raven SUAV system. We compare doctrine versus practice using the Department of Defense's (DOD) Doctrine, Organization, Training, Material, Leadership, Personnel, Facilities (DOTML-PF) model as the primary logic construct.

The report begins by providing a background of the Raven SUAV, to include its evolution from a COTS item to the Army's SUAV of choice, and how it has impacted the warfighter. Next, the authors provide an overview of DOTML-PF in order to provide a basis for comparing doctrine and practice. The study then looks in-depth at doctrine and practice using DOTML-PF as the model for revealing differences between the two. Finally, the authors analyze these differences and recommend solutions to mitigate shortfalls in actual Raven SUAV usage on the battlefield.

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THE RAVEN SMALL UNMANNED AERIAL VEHICLE (SUAV), INVESTIGATING POTENTIAL DICHOTOMIES BETWEEN DOCTRINE AND PRACTICE

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Submitted in partial fulfillment of the requirements for the degree of

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ABSTRACT

The goal of this MBA Project is to investigate possible disconnects between doctrine and practice in the employment of the Raven Small Unmanned Aerial Vehicle (SUAV). The Army's current Small UAV requirements are based upon the Future Combat System's Operations Requirements Document and has not been validated at the platoon or company level. The Raven SUAV is a Commercial off the Shelf (COTS) item that swiftly became the Army's Small UAV of choice for operations in Afghanistan and Iraq. Doctrine and Techniques, Tactics, and Procedures (TTP) have been written for the Raven SUAV; however, it is not standard practice for all units operating the system abroad. The last review of the SUAV operational requirements was conducted in 2003 but did not specifically address its usage on the battlefield. In an attempt to fill that gap, this project focuses on real-world usage of the Raven SUAV system. We compare doctrine versus practice using the Department of Defense's (DOD) Doctrine, Organization, Training, Material, Leadership, Personnel, Facilities (DOTML-PF) model as the primary logic construct.

The report begins by providing a background of the Raven SUAV, to include its evolution from a COTS item to the Army's SUAV of choice, and how it has impacted the warfighter. Next, the authors provide an overview of DOTML-PF in order to provide a basis for comparing doctrine and practice. The study then looks in-depth at doctrine and practice using DOTML-PF as the model for revealing differences between the two. Finally, the authors analyze these differences and recommend solutions to mitigate shortfalls in actual Raven SUAV usage on the battlefield.

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This thesis is dedicated to the both of our families whose love and support allowed us to turn the dream of completing this report into a reality. We love you dearly.

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EXECUTIVE SUMMARY

A. PURPOSE

The purpose of this report is to study the Raven Small Unmanned Aerial Vehicle (SUAV) and determine whether or not the system is owned, operated, and maintained in accordance with current doctrine.

B. INTRODUCTION

1. Background In the mid-1990s the Army realized that there was a need for a SUAV that could be used for Reconnaissance, Surveillance, and Target Acquisition (RSTA) at the company and platoon level. As years passed, the need for SUAVs continued to increase with forces deploying to engage in asymmetrical warfare. The Army's Special Operations community was the first to experiment with SUAVs as operations began to intensify in Afghanistan and Iraq. Today, the Army and the Marine Light Infantry forces are also using SUAVs in Iraq. The primary SUAV being used by the Army is the Raven which was a Commercial Item (CI) material solution to meet warfighter requirements.

2. Project Objectives This research project is specifically focused on the following primary research question: Are there differences between doctrine and practice with regard to Raven SUAV operations?

The subsidiary research questions are: Is there an efficient and effective feedback loop for Raven SUAV lessons learned? Are "real-world" lessons learned systematically incorporated into Raven SUAV doctrine? How is PM-UAV/Army achieving leader buy-in for the Raven SUAV?

C. METHODOLOGY

1. Conduct research to determine what requirements were written into the Future Combat Systems (FCS) Operational Requirements Document (ORD) for the SUAV and other documentation pertaining specifically to the Raven SUAV.

2. Conduct research to determine the warfighter's real-world requirements in Iraq and Afghanistan and how they are operating the system.

3. Review the FCS ORD and compare it with the current Tactics, Techniques, and Procedures (TTP) of the ground forces.

4. Review deployed unit SOPs to determine how they communicate lessons learned to higher headquarters.

5. Conduct research to determine whether or not Raven SUAV lessons learned affect developing doctrine for the system.

D. FINDINGS AND ANALYSIS

The differences in Raven SUAV usage among deployed commanders form the dichotomies between doctrine and practice with regard to this system. Using DOTML-PF as a framework, we discovered that Doctrine is the component of DOTML-PF that has the most dichotomies when comparing "Doctrine" to "Practice" in Raven SUAV operations. There are missions listed in the Raven TTP Manual that are executed as written and others that are modified to meet the commander's operational needs. Furthermore, commanders are using the system to conduct missions that are not written in the Raven TTP Manual, but are of value and continue to preserve lives and increase unit effectiveness.

These differences, which many key leaders have deemed the "commander's innovativeness," brings to focus whether there is an efficient and effective feedback loop for lessons learned. The feedback loop for the Raven SUAV remains a work-in-progress as a result of its newness to the Army community. The current process for getting feedback information from the field is executed in two ways. In some cases an Operational Assessment (OA) team will travel to theater to collect information, and then

report it to the Department of the Army and TRADOC. On other occasions, a Center or School House will do an independent survey either during or after a rotation by a certain unit. Usually those surveys are After Action Reports (AAR) conducted shortly after a unit has returned.

The bottom line is that because dichotomies exist between doctrine and practice in Raven SUAV usage, it is imperative that units capture the good and the bad while operating the system. The mechanism for relaying this critical information from the field must be made standard and checks must be conducted to ensure that the information is put into doctrine for follow-on units to execute.

E. RECOMMENDATIONS

1. Decision makers need to establish one standard mechanism for reporting Raven SUAV lessons learned for incorporation into evolving doctrine. Capturing how units employ the system is perishable feedback loop data that must be effectively and efficiently disseminated.

2. The Infantry Center Directorate of Combat Development (DCD) is doing an excellent documenting how the Raven SUAV is being employed. They have traveled to Iraq to ensure that the procedures for how the Raven employment are being annotated and put into appropriate documentation. The Infantry Center DCD personnel need to ensure these lessons learned are used for developing future requirements and refining current TTPs as it is disseminated through established feedback mechanisms.

3. Leader buy-in to the Raven SUAV was recognized early by the Project Manager‘s office as being one of the most important issues for the success of the Raven system. The PM office’s primary venue for gaining leader buy-in is the New Material Introductory Brief (NMIB). This briefing informs the leadership of the Raven SUAV capabilities and limitations. The PM Office should continue educating commanders at all levels to ensure they are fully aware of the Raven SUAV and how much of a combat-multiplier the system really has become.

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I. INTRODUCTION

A. PURPOSE

The purpose of this report is to study the Raven Small Unmanned Aerial Vehicle (SUAV) and determine whether or not the system is owned, operated and maintained according to doctrine. To accomplish this we analyze the Raven's Tactics, Techniques, and Procedures Manual, Operator's Manual, and the Small UAV Operational Requirements Document. This analysis was then compared to lessons learned from units operating the Raven SUAV in Afghanistan and Iraq to exploit any gaps in information flow between the user and the agency writing the Raven SUAV doctrine. Figure 1 depicts the Logic Construct we will use for this report.

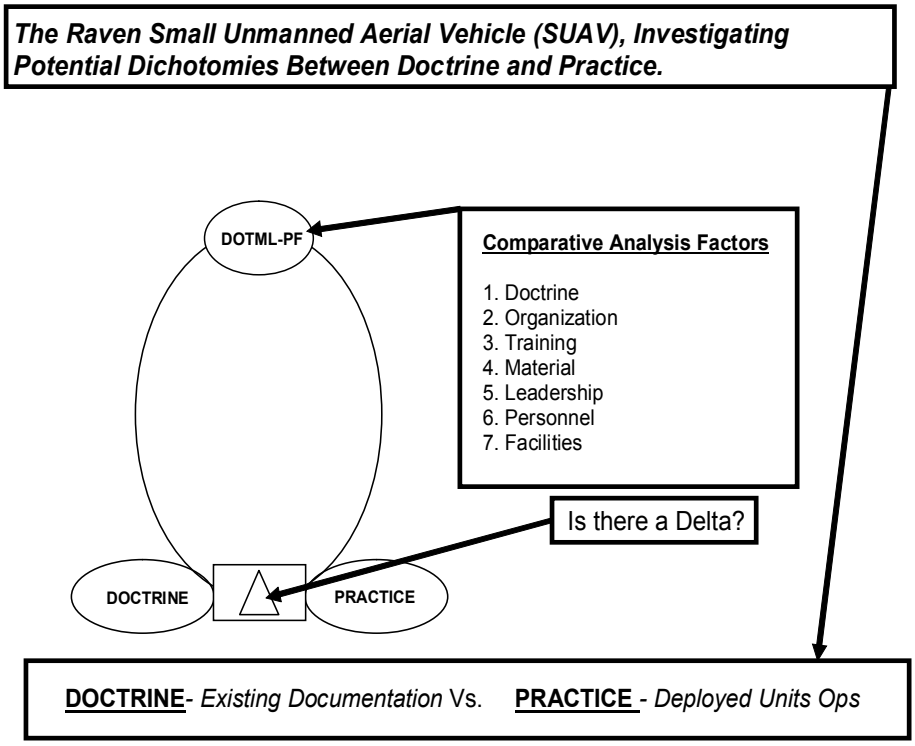


Figure 1. Logic Construct

B. BACKGROUND

In the mid 1990s the Army realized there was a need for a SUAV that could be used for Reconnaissance, Surveillance and Target Acquisition (RSTA) at the company and platoon level. The initial look was to sponsor a Micro Air Vehicle Advanced Conceptual Technical Demonstration (MAV ACTD) to display the capabilities and benefits of having a UAV at these levels. The MAV ACTD was divided into three areas of responsibility. [Ref. 1]

The three areas of responsibility were, The Technical Manager, the Operational Manager, and the Transition Manager. The Technical manager was responsible for overall program management and delivery of the MAV system. The Operational Manager was the United States Army Pacific Command, Deputy Chef of Staff for Intelligence (USARPAC, G2/DCSINT). He was responsible to develop the requirements, plan and execute the experimentation, and conduct the Military Utility Assessment of the MAV System. The Transition Manager was the Project Manager for Unmanned Aerial Vehicles and was responsible for the transition of the MAV system into current and/or future force. The MAV ACTD had many ups and downs due to poor planning and management. There is now new leadership and they have reenergized the program.

The need for SUAVs grew with forces deployed into Afghanistan and subsequently Iraq. The initial users of SUAVs were the Special Operations Forces and the Rangers in the mountains of Afghanistan. Today, the Army and the Marine Light Infantry forces are also using SUAVs in Iraq. The primary SUAV being used by the Army is the Raven which was a Commercial off the Shelf (COTS) material solution to meet warfighter requirements. The Army is on board to purchase an additional 250 systems in fiscal year 2005, and the Source Selection Evaluation Board (SSEB) has convened to award a contract to meet the requirements of the Joint Requirement Oversight Council (JROC)-Approved Capabilities Development Document (CDD).

The issue concerns the supportability and the maintainability of the SUAV at levels below battalion. Chapter II provides background information for the Raven SUAV.

C. RESEARCH QUESTIONS

This research project is specifically focused upon the following primary research question:

- Are there differences between doctrine and practice with regard to Raven SUAV operations?

The subsidiary research questions are:

- Is there an efficient and effective feedback loop for Raven SUAV lessons learned?
- Are "real-world" lessons learned systematically incorporated into Raven SUAV doctrine?
- How is PM-UAV/Army achieving leader buy-in for the Raven SUAV?

D. SCOPE

The scope of this report is limited to the Raven SUAV Doctrine versus Practice and how it relates to DOTLM-PF. The literature that supports this study includes defense planning rules and policies, Army Objective Force concept and requirements documentation, Future Combat Systems Operational Requirements Document (ORD), Rucksack Portable ORD, SUAV ORD, slides from JROC and industry briefings, as well as various defense publication articles regarding SUAVs.

E. METHODOLOGY

Compare and contrast differences between how current Army documentation theorizes units should own, operate, and maintain their SUAV fleet versus how units in Afghanistan and Iraq are actually conducting operations. DOTLM-PF is the analytical mechanism used for conducting this comparison.

(1) Conduct research to determine what requirements were written into the FCS ORD for the SUAV and other documentation pertaining specifically to the Raven SUAV.

(2) Conduct research to determine the warfighter's real-world requirements in Iraq and Afghanistan and how they are operating the system.

(3) Review the FCS ORD and compare it with the current Tactics, Techniques, and Procedures (TTP) of the ground forces.

Identify whether or not there is a feedback loop or some other mechanism of ensuring lessons learned are incorporated into developing Raven doctrine and Standard Operating Procedures (SOP).

(1) Review deployed unit SOPs to determine how they communicate lessons learned to higher headquarters.

(2) Conduct research to determine whether or not Raven SUAV lessons learned affect developing doctrine for the system.

F. THESIS ORGANIZATION

Chapter I: Introduction. Identifies the focus and purpose of this project as well as the primary and subsidiary research questions.

Chapter II: Background. Provides a basic overview of the Raven SUAV.

Chapter III: Doctrine, Organization, Training, Material, Leadership, Personnel, Facilities (DOTML-PF) Overview.

Chapter IV: Raven SUAV requirements in "Doctrine"

Chapter V: Raven SUAV requirements in "Practice"

Chapter VI: Analysis of Doctrine versus Practice

Chapter VII: Findings and Recommendations. Summarizes the findings of the research, answers the research questions, and identifies questions for further study.

II. BACKGROUND

A. CHAPTER OVERVIEW

The purpose of this chapter is to provide background information on the Raven SUAV currently being used by the United States Army in Afghanistan and Iraq. This chapter includes information on the origins of the Raven, its developmental history, and its current usage and status. The chapter concludes by describing the Army's specific acquisition strategy for the system.

B. THE RAVEN SMALL UNMANNED AERIAL VEHICLE (SUAV)

The Raven SUAV depicted in Figures 1 and 2 is a hand-launched SUAV that provides beyond line-of-site (LOS) reconnaissance and surveillance. The system transmits live video images and compass headings (location information) to a ground control unit (GCU) and remote video terminal (RVT), enabling operators to navigate, search for targets, recognize terrain, and records all information for later analysis. [Ref.2] Tables 1 and 2 depict the Raven SUAVs Characteristics and System Components respectively.

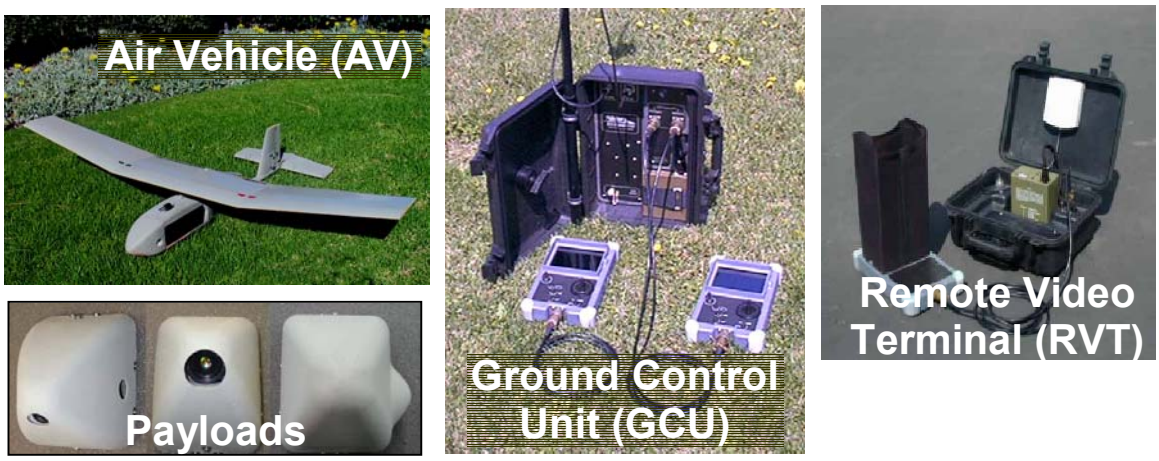


Figure 2. Raven SUAV [Ref. 3]

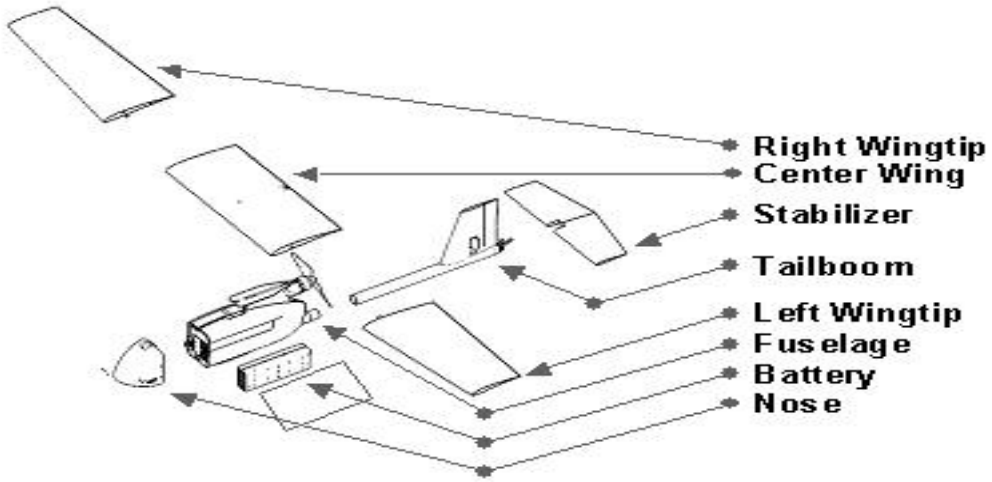


Figure 3. Raven SUAV System Breakdown [Ref. 2]

Parameter	Characteristic
Wingspan	55 inches
Length	36 inches
Structure	modular, Kevlar™ composite
Weight (with payload)	4.0 lbs
Payload Nose Weight	6.5 oz
Operating Altitude	150 to 1000 ft AGL
Nominal Low Altitude	100 ft
Cruise Speed	30 mph (13.5 m/s)
Range	10 km (LOS)
Climb Rate	900 ft/min @ 2000 ft AGL
Turn Rate (360º)	25 seconds
Motor	direct drive electric
Aircraft Batteries	$LiSO_2$ (single-use) Li-Ion (rechargeable)
Flight Duration	90 + min rechargeable 90 + min single-use
Launch	hand
Landing	commanded autoland deep stall
Navigation	P(y)-code GPS and electronic compass
Flight Control	manual or autonomous

Table 1. Raven SUAV Characteristics [Ref. 2]

Component	Quantity
Aircraft	2-4
EO Camera Payload Nose – Front & Side Look	1
IR Camera Payload Nose –Front Look	1
IR Camera Payload Nose –Side Look	1
GCU	1
Remote Video Terminal	0-1

Table 2. System Components [Ref. 2]

On 08 January 2003, the Army UAV Program Office briefed the Vice Chief of Staff of the Army (VCSA) on the SUAV Requirements to support units deployed primarily in Afghanistan and Iraq. Following the briefing, the VCSA stated, "I don't want to wait 20 years for a platoon UAV." [Ref. 4] Less than 3 weeks later, on 21 January 2003, the VCSA and the Army G3 approved the 101st Airborne Division for a rapid acquisition and equipping/fielding of the Raven SUAV in conjunction with the Rapid Equipping Force initiatives. On 16 May 2003, the Army UAV Program Office received $1.9M in funding and signed a letter contract for five Raven SUAV systems with options for future procurements as funding become available.

By September 2003, the Raven SUAV had achieved many successes during Operations ENDURING FREEDON and IRAQI FREEDOM and was designated as an Urgent Wartime Requirement by the Army G3. The Deputy Secretary of Defense directed the procurement of 185 Raven SUAVs within thirty days of the G3's designation. These systems were issued to combat arms units both in garrison preparing for deployment, and abroad already engaged in the war on terrorism.

C. RAVEN SUAV MISSIONS

Raven Teams may perform missions as an independent element (surveillance, reconnaissance, Forward Operating Base (FOB) security) or they may act as a subordinate element supporting a larger operation (convoy security, assault, cordon and search). Raven Teams must be prepared to conduct mission planning and pre-mission coordination when employed in either role. [Ref. 5]

The Raven SUAV is currently owned, operated, and maintained at the company level. The extensive planning involved in coordinating and conducting its missions coupled with the logistical effort necessary to maintain the equipment, have caused key Army leaders to hypothesize whether or not it is feasible to execute Raven missions below the battalion level.

D. RAVEN SUAV ACQUISITION STRATEGY

The Army has a specific acquisition strategy based on requirements and funding. The Raven SUAV is the anomaly because it did not follow the traditional acquisition lifecycle process. On 2 January 2004, AeroVironment Corporation was awarded a $20,700,000 firm-fixed-price/cost-plus-fixed-fee contract for procurement of 170 Raven SUAVs. Work was performed in Simi Valley, California, and was completed by 31 December 2004. [Ref. 6] Shortly after production of these systems, units owned, operated, and maintained the Raven SUAV before it underwent the phases of the Acquisition Product Lifecycle. The plan through December 2005 is to continue to equip Army units with the system and compete it in the solicitation phase in hopes of meeting the Army Class I UAV requirement for Future Combat Systems (FCS).

E. CHAPTER SUMMARY

This chapter described the evolution of the Raven SUAV from its original inception to its current state. Although the Raven has not developed through the Acquisition Product Lifecycle Process it has been the surveillance aircraft of choice for lower-level Army units deployed in Afghanistan and Iraq since the onset of Operation Enduring Freedom and Operation Iraqi Freedom. Chapter III will provide an overview of the Army's concept of Doctrine, Organization, Training, Material, Leadership, Personnel, and Facilities (DOTML-PF) which will be the basis from which we examine the feasibility of owning, operating, and maintaining the Raven SUAV below battalion level.

III. DOCTRINE, ORGANIZATION, TRAINING, MATERIAL, LEADERSHIP, PERSONNEL, FACILITIES (DOTML-PF) OVERVIEW

A. CHAPTER OVERVIEW

The purpose of this chapter is to provide an overview of DOTML-PF which is the model the authors use to evaluate the feasibility of owning, operating, and maintaining the Raven SUAV below the battalion level. DOTML-PF is a very useful tool for looking at a large issue or set of issues, operation(s), or business area and breaking it apart into more discrete, manageable sets of tasks and deliverables. [Ref. 7] This chapter defines and discusses each component of DOTML-PF in order to set the stage for comparing theory versus doctrine for operating the RAVEN SUAV in chapters IV and V respectively.

1. Doctrine

Doctrine products include doctrine publications, Tactics, Techniques, and Procedures, (TTP), operating procedures, regulations, checklists, or policy which governs or guides the way the military conducts business. [Ref. 7]

2. Organization

Organization products and services include actual organizations needed to conduct an operation or business, the visual representation of those organizations, organizational characteristics, and opportunities and challenges in utilizing them to perform an operation or conduct business. [Ref. 7]

3. Training

Training products and services encompass training content and all methods of delivering that content to its intended audience which enables performance and support of the mission. [Ref. 7]

4. Material

Material products are traditionally what have been associated with the defense acquisition process to include weapons, platforms, communication equipment, medical equipment, transportation, and training software. It is important to remember that even

though materiel may be used to directly perform a mission, it may also support another DOTML-PF component that supports the mission, especially facilities and training. [Ref. 7]

5. Leadership

The leadership aspect of DOTML-PF deals with the management and implementation of change across the DOTML-PF spectrum. [Ref. 7]

6. Personnel

The personnel component of DOTML-PF is primarily to ensure that qualified personnel are there to support a capability. This includes identification of the knowledge, skills, abilities, and competencies needed to perform a position, job or task. It may involve creation of new occupational specialties to support new missions, threats, and technologies and revision of those specialties over a period of time. [Ref. 7]

7. Facilities

Facilities products and services include supplies, engineering support, and much of what is currently associated with logistics. [Ref. 7]

B. CHAPTER SUMMARY

This chapter defined each component of DOTML-PF from a requirements perspective as it pertains to analyzing and solving issues within the Department of Defense (DoD). The DoD's understanding of this concept is still evolving as the two most difficult areas to describe in a requirements context are organization and leadership. This concept is DOTML-PF is a valuable analytical tool that can be used to develop requirements and solutions to military problems. Rarely is looking at one component of DOTML-PF sufficient for developing a solution to a requirement. Even though program dollars are tied to the material component of DOTML-PF, requirements for other areas must be developed in order to develop and field effective solutions. [Ref. 7]

IV. RAVEN SUAV REQUIREMENTS IN "DOCTRINE"

A. CHAPTER OVERVIEW

The purpose of this chapter is to describe the doctrine for the Army's Raven Small Unmanned Aerial Vehicle (SUAV) requirements as they relate to the DOTLM-PF. These requirements were initially developed at the beginning of 2001 in a draft version of the SUAV Operational Requirements Document (ORD). This ORD was never finalized or approved; however, it underwent staffing through the core members of the UAV Integrated Concept Team (ICT). The core members consisted of the Army Aviation Directorate of Combat Development (DCD), the Infantry Center DCD, the Military Intelligence Center DCD, and the Armor Center DCD. The requirements listed in the SUAV ORD became the framework for the Class I UAV requirements that are written into the current Future Combat System (FCS) ORD.

Although staffed through a vigorous IPT process, these requirements do not fully represent what the warfighters are doing in theater. There is a real-world requirement for a SUAV that was sorely needed in Iraq and Afghanistan to combat insurgents. Since there was no military system available, the Army selected a Commercial Off the Shelf (COTS) version of a SUAV. This version was the Raven and is produced by AeroVironment located in San Diego, CA. This is the SUAV that the majority of the Army is using in Iraq today.

1. Doctrine

Doctrine products include doctrine publications; Tactics, Techniques, and Procedures, (TTP); operating procedures, regulations and checklists, which guides the way the military conducts business. The doctrine we analyzed is derived from the documentation supporting the Raven SUAV. The user manual and the TTPs are currently the only documentation available to support the deployed Raven SUAV.

The Raven SUAV improves situational awareness at company level and below. These systems, used for company and platoon reconnaissance on the ground, are critical to the maneuver company commander's decision-making process. Aviation, combat support, and combat service support units benefit from the improved situational

awareness (SA) and associated force protection provided by the Raven. The use of the Raven provides commanders with real-time, beyond-line-of-sight SA and the ability to detect, identify, and/or avoid enemy units or areas of threat by providing sensor-based information. By using the Raven, a greater standoff capability is created which gives units greater success and reduces the risk of putting soldiers into dangerous situations. By doing this, leaders are able to make decisions faster and with greater precision.

The Raven SUAV has documentation to support its operation and has current TTPs. The TTPs are being verified in Iraq and Afghanistan by the Army and Marine Corps. The TTP's were written by the Infantry Center DCD and dated June 30, 2004. They received information from the field and were able to accurately document these procedures for future reference. These TTPs are being continuously updated and their refinement will not be complete until more data is received from the field. This is a prime area for future research.

The Raven is a system that was directly purchased from the contractor and provides an eye-in-the-sky for the ground commander. The reason for the COTS purchase is because there was nothing available in the Army's inventory to support this doctrinal requirement.

The primary users of the Raven system are soldiers at the Company and Platoon level. They would use these systems to gather real-time surveillance and for force protection. The system could have a secondary use of providing various security missions. They would range from convoy security to runway and airfield security.

2. Organization

The Raven SUAV will primarily be used below company level and will be divided within the platoons. One soldier is required to operate and maintain the Raven. There are certain components of the system that will require higher level maintenance support.

3. Training

Training will be conducted at the unit level; however, the methodology for training is not written. The draft Raven SUAV training log contained in Appendix F of the Raven Manual v.2. Training on these systems will be conducted initially at Advanced

Individual Training and at the Officer Basic Course. All leaders must understand Raven's capabilities in order to employ them to their full potential. The Infantry Center Directorate of Combat development will visit units to provide Key Leaders a New Materiel Introductory Brief (NMIB). The purpose is to educate the leadership on the benefits and value of using the Raven.

As with any other weapon system, there must be a training plan in place that document when and how the training is conducted. There must be a task, condition, and standard for the Raven and all operators must be capable of accomplishing these tasks. In order to accomplish the training there must be spares calculated into the total number of systems needed. The planned amount is 10% of the total Table of Organization and Equipment (TOE) and Table of Distribution and Allowances (TDA) systems requirements. Table 3 depicts the breakout of the total Small Unmanned Aerial Vehicle System Basis of Issue Plan (BOIP).

TOE	**Sub-Total**	**Total**
BCT	1150 Systems	1150
Supporting Brigades	1116 Systems	2266
TDA		
TRADOC Schools	17 Systems	2283
USSOCOM		
All Organizations	348 Systems	2631
Spares		
10%	263 Systems	2894
TOTAL REQUIREMENT		**2894 Systems**

Table 3. Raven SUAV Breakout [Ref. 8]

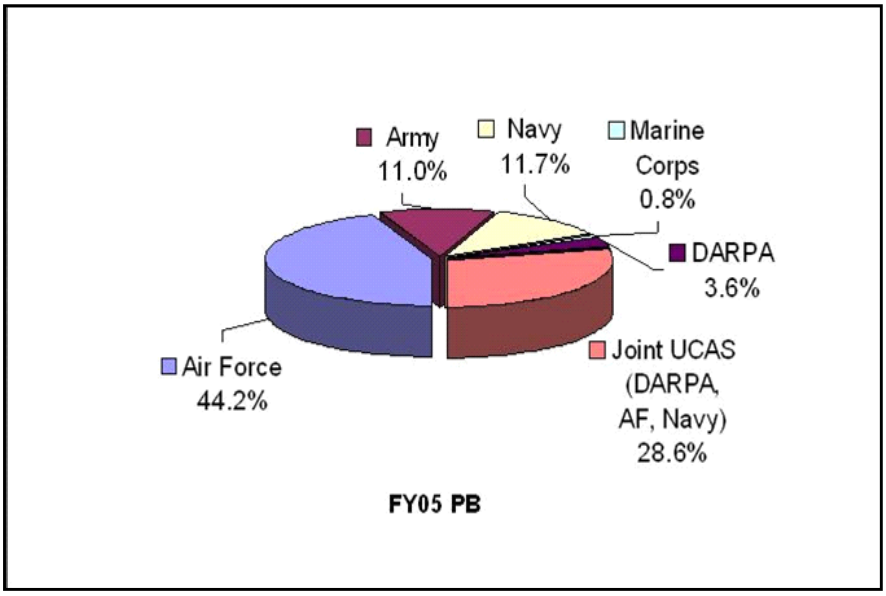
Training teams will be established to train and educate the operators. There will also be training provided to the leadership within the command to ensure they properly understand how to employ the Raven. In order to properly employ the Raven SUAV the leadership must fully understand its capabilities. Currently, there are no means to gather information on whether or not the training is measured and monitored accurately.

Another issue is that the training is neither sufficiently staffed nor funded. The Raven operator does not have a skill identifier so there is no dedicated MOS assigned to operate the SUAV.

4. Material

The material solution for the Army's UAV requirement came in the form of a Commercial Item (CI). Below are the funds available for the Army UAV programs as compared to the other services. It was originally thought that there would be more funding available as a result of the war in Iraq.

U.S. Department of Defense UAVS Service Budgets
(FY05 PB%) (RDTE, Procurement, OMA)



[8]

Figure 4. DoD UAV Service Budgets [Ref. 8]

The Raven was originally scheduled to have $58.5 Million for procurement. From September of 2003 through October of 2004 the Army procured 185 Systems. This was due to VCSA and the Army G3 approving request by the 101st Airborne Division for a rapid acquisition and equipping/fielding of a SUAV. This was in accordance with the Rapid Equipping Force Initiatives which had $2.4 million already allocated. In May 2003 the Army received $1.9 million and signed a letter contract for five Raven Systems with options for future procurement. These systems arrived in October 2003 and training

and maintenance support began. On 16 October 2003 the Secretary of Defense directed procurement of the 185 Raven systems. The cost will probably go up due to the great success of this system in Iraq.

U.S. Department of Defense UAVS Service Budgets

(FY05 PB $M) (RDTE, Procurement, OMA)

	FY04	FY05	FY06	FY07	FY08	FY09	Total
Air Force	985.7	1089.8	1107.3	1131.4	1079.7	1098.9	6492.8
Global Hawk	625.4	717.6	764.2	872.6	794.3	725.4	4499.5
Predator A	241.2	271.0	203.7	194.6	199.2	233.0	1342.7
Predator B	119.1	101.2	139.4	64.2	86.2	140.5	650.6
UCAV-AF							
% of Total	55.24%	45.83%	45.66%	51.32%	36.33%	37.57%	44.20%
Army	225.9	288.1	201.7	192.2	340.4	369.9	1618.2
Shadow	127.8	155.2	105.4	84.5	62.5	57.2	592.6
Hunter	29.2	27.9	27.9	25.9	24.5	25.3	160.7
RAVEN	46.0	12.5					58.5
ER/MP	22.9			51.2	131.9	160.9	366.9
FCS		92.5	68.4	30.6	121.5	126.5	439.5
% of Total	12.66%	12.11%	8.32%	8.72%	11.45%	12.65%	11.02%
Navy	136.3	166.3	220.6	381.3	409.8	411.3	1725.6
UCAV-N							
BAMS	24.8	113.4	141.8	316.4	377.9	391.3	1365.6
Fire Scout	36.1	42.9	58.8	44.9	11.9		194.6
GHMD	75.4	10.0	20.0	20.0	20.0	20.0	165.4
% of Total	7.64%	6.99%	9.10%	17.30%	13.79%	14.06%	11.75%
Marine Corps	35.5	26.5	23.6	11.5	11.3	11.5	119.9
Dragon Eye	3.0	8.9	13.0	1.3	1.2	1.2	28.6
Pioneer IP	32.5	17.6	10.6	10.2	10.1	10.3	91.3
% of Total	1.99%	1.11%	0.97%	0.52%	0.38%	0.39%	0.82%
DARPA	65.0	97.0	124.0	105.0	87.0	47.0	525.0
UCAR	50.0	77.0	109.0	85.0	87.0	47.0	455.0
A-160 Hunmmingbird	15.0	20.0	15.0	20.0			70.0
% of Total	3.64%	4.08%	5.11%	4.76%	2.93%	1.61%	3.57%
Joint(DARPA ,AF, Navy)	336.0	710.4	747.9	383.0	1043.5	986.5	4207.3
J-UCAS	336.0	710.4	747.9	383.0	1043.5	986.5	4207.3
% of Total	18.83%	29.87%	30.84%	17.37%	35.11%	33.73%	28.64%
DoD Total	1784.4	2378.1	2425.1	2204.4	2971.7	2925.1	14688.8

Figure 5. DoD Service Budget ($) [Ref. 8]

5. Leadership

The leadership aspect of DOTML-PF deals with managing and implementing change across the DOTML-PF spectrum. There are different levels of leadership that are affected within the Raven System. The lowest level is the operator and is found at the platoon level. The operator is responsible for the maintenance, operation, and care of the Raven. The missions flown are dictated by the command, based upon intelligence reports disseminated throughout the organization. The training program brings in the leadership to ensure that they understand how to properly employ the Raven system. In some cases, the leadership has not "bought into" the value of the Raven System and therefore the system is not being utilized to its full potential.

The Infantry Center Directorate of Combat Development is trying to educate the leadership within the combat Divisions by conducting New Materiel Introductory Briefs (NMIB). This will help mitigate Raven SUAV leadership training shortfalls and educate them on the advantages of the system.

6. Personnel

The personnel component of DOTML-PF is primarily to ensure that qualified personnel are available to support a capability. This includes identification of the knowledge, skills, abilities, and competencies needed to perform a position, job, or task. It may involve creation of new occupational specialties to support new missions, threats, and technologies and include revision of those specialties over a period of time.

New training programs will be needed to fully support the Raven UAV. Since Raven was not a typical Army acquisition, there was not a valid plan to support Raven system maintainability. The personnel are currently training prior to deployment. Trainer teams are also going to units already deployed to train replacement personnel and update the TTPs. The primary user will also conduct the majority of maintenance and support. This maintenance will be limited and will be easy to do. This significantly reduces the burden on the operator. Major repairs will be at depot level, and the Air Vehicle will be changed out on a one–for-one basis.

7. Facilities

There are no actual facilities required to operate the Raven system. The only issue unique to the UAV community is the ability to acquire the airspace needed to fly the Raven. The Raven poses a potential risk to manned aviation assets and other unmanned aerial vehicles on the battlefield.

B. CHAPTER SUMMARY

This chapter examined each component of DOTML-PF in doctrine from a requirements perspective as it pertains to Raven System. The Doctrine, Organization, Training, Material, Leadership, Personnel and Facilities were examined based on the current information available. Since the Raven is a fairly new system this information

and the way the Army conducts operations in regards to the Raven are in their infancy stage.

All areas of DOTML-PF are important but we believe that the Doctrine is one of the most important. Until the doctrine is thoroughly evaluated, the Army will not know if it is written correctly. The TTPs are being evaluated on a daily basis in Iraq by the users. The key link between the user and Doctrine developers continues to evolve. As each unit employs the Raven, they will find better ways to use it, from a surveillance vehicle to a noise producer to entice enemy out of hiding. This information needs to be documented, organized and captured so it can better train the warfighter in the future. The doctrinal support for the Raven is still undergoing revisions based upon the information received from the field. That information is valuable and will change the current doctrine of how we view UAV requirements in support of DOTLM-PF.

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V. SMALL UAV (SUAV) REQUIREMENTS IN "PRACTICE"

A. CHAPTER OVERVIEW

The purpose of this chapter is to present the "practice" portion of how Small UAVs are being operated and maintained by providing an in-depth view from a Doctrine, Organization, Training, Material, Leadership, Personnel, and Facilities (DOTML-PF) perspective. DOTML-PF is an effective tool for investigating and gathering all the pertinent data needed to draw conclusions in order to formulate a complete, relevant, and correct set of requirements for solving operational issues and deficiencies. [Ref. 7] In this chapter DOTML-PF is the framework we use to understand how the Raven SUAV has been employed.

The majority of the data in this chapter was gathered through an Independent User Assessment (IUA) of the Raven SUAV conducted by the Electronics and Special Developments Division (ESDD) of the Directorate of Combat Developments (DCD). The user assessment focused upon the training, employment, and overall operations of the system in a combat environment through the conduct of operational employment interviews with Raven operators and their Chain of Command. This chapter uses each component of DOTML-PF to evaluate how units are operating and maintaining the Raven SUAV from a real-world perspective. Chapters IV and V form the basis for comparing the "doctrine" versus "practice" of Raven SUAV operations that will be discussed in Chapter VI.

1. Doctrine

The IUA revealed that the Tactics, Techniques, and Procedures, (TTP) for operating the Raven SUAV varies between units deployed to Afghanistan and Iraq. Operations range from reconnaissance missions to perimeter and convoy security, spanning across all spectrums of the battlefield. The two most common uses of the Raven SUAV are to (a) conduct reconnaissance missions to develop target books for future operations and (b) assist convoys with identifying Improvised Explosive Devices

(IED), potential ambushes, and alternate avenues to travel when traffic is congested along a specified route. These uses provide the Blue Forces (BLUFOR) Commander with real-time eyes on the enemy.

The Raven SUAV is also used in a dual role with the larger Shadow UAV. In this scenario both UAVs are used in a layered effect by looking deep with Shadow and close-in with Raven system. The Shadow operates from roughly 0500 hrs to 2300 hrs daily with the Raven being used when cued by Shadow or manned assets. The Raven performs perimeter and convoy security, assaults, raids, and Quick Reaction Forces (QRF) missions. [Ref. 9]

The Raven's dual role with the Shadow extends beyond looking at the deep and close fight. These systems are also used to facilitate command and control of the battlefield. The UAVs monitor enemy movement and positions and relay that information to the maneuver units on the battlefield. The Raven's size and swiftness allows it to look over walls and onto rooftops, identify enemy positions, and maneuver to positions of advantage. All of these uses give the commander an advantage before and during combat engagements.

2. Organization

The Raven SUAV is currently owned, operated, and maintained at four different levels within the Army that range from brigade to platoon. Since the mission/management focus is different at each level, the use of the Raven SUAV varies accordingly. The IUA revealed the Raven SUAV is most effectively used at the Brigade Combat Team (BCT) level.

3. Training

The concept of operations for Raven SUAV training is divided into two phases and is conducted both in CONUS and OCONUS. Phase I operator training is conducted at Camp Udairi, Kuwait; Huntsville, Alabama; and Fort Benning, Georgia. This training consists of an 8-to-10 day program of instruction focused upon training soldiers on how to operate the system. The instructor to student ratio is 1:4 with a primary instructor and 2:8 with the addition of an assistant instructor. Students are given classroom instruction covering a wide variety of topics from characteristics and capabilities, airspace and

frequency management, and mission planning. The bulk of the training, however, consists of hands-on flying of the Air Vehicles (AV) during both day and night. Flight training is conducted from day one through the final day of the course. Each day the students are rotated to increasingly difficult situations such as complex terrain and mobile operations (HMMWV). [Ref. 9] Phase II collective training is when operational training personnel deploy to unit sites to train command and staff elements on the Raven SUAV System. Additionally these operational personnel deploy with units to help establish CONOPS and TTPs.

4. Material

Thirteen small UAV prototypes were examined for the Army use. Of those thirteen, the top three were the Rucksack Portable UAV (RPUAV), the Micro Air Vehicle (MAV), and the United States Marine Corps' Small Unit Remote Scouting System (SURSS)/Dragon Eye. The Project Manager, Unmanned Aerial Vehicle System (PM-UAVS) conducted a comparison of the Raven SUAV and the Dragon Eye and discovered that the Raven was better suited for the Army's SUAV needs. [Ref. 10] While there are other SUAV systems operated by Marine Corps and Navy elements, the Raven SUAV remains the system of choice for Army units deployed in Afghanistan and Iraq.

5. Leadership

The most common observance by the IUA Team concerning units operating the Raven SUAV is that the leadership at all levels remains unaware of the Raven's capabilities and is therefore somewhat reluctant to employ the system. Furthermore, unit leadership is generally uninformed about the tactical capabilities the Raven SUAVS can provide. As a result, the system has an almost non-existent role in unit operations.

Despite the overall lack of knowledge, there are many success stories. One in particular is that of MAJ Chlebowski of 1-6 FA. He said, "The Raven is the best piece of equipment out here. We couldn't have killed as many enemy forces as we have, and saved as many lives without it. Don't let the Army cancel this!"

6. Personnel

Soldiers operating the Raven SUAV in Afghanistan and Iraq are removed from their assigned military specialty to operate the system. These soldiers are generally assessed as qualified to conduct Raven SUAV operations after an 8-to-10 day program of instruction. Soldiers operating the Raven SUAV must be mature and responsible, possess strong map-reading skills, and must be capable of working with battalion/company commanders and their associated staffs. Although there is no formal occupational specialty for Raven SUAV operators, the advisability of creating one is being discussed.

7. Facilities

There are adequate facilities in both Afghanistan and Iraq to maintain the Raven SUAV system. Repairs are conducted at a Logistics Support Center (LSC) managed by a Logistical Support Contractor (LSC) assigned to PM-UAVS. The LSC coordinates pick-up and return of the damaged equipment with the unit and either personally delivers the parts, has the unit pick them up from his facility, or sends them via cargo to the unit's Forward Operating Base (FOB). Repairs are rarely conducted at the unit-level as there are no trained UAV maintainers below Depot level.

B. CHAPTER SUMMARY

This chapter presented the "practice" portion of how Small UAVs are actually operated and maintained by providing an in-depth view from a DOTML-PF perspective. Knowledgeable users feel the Raven SUAVS significantly contributes to the ongoing war in Afghanistan and Iraq and that it is a proven combat multiplier. The Raven SUAV directly and significantly contributes to fewer casualties.

There is a huge difference between how units employ the Raven SUAVS. Some units are extremely proficient with the system and have fully integrated it into their scheme of maneuver. Other units barely use the Raven and apparently do not understand the capabilities it can bring to the fight. Soldiers are finding new and creative ways to employ the Raven and share its information with leaders. Leaders that are responsive to the soldier's ideas are finding that the Raven has become an invaluable asset.

VI. ANALYSIS OF DOCTRINE VERSUS PRACTICE

A. CHAPTER OVERVIEW

This chapter provides a discussion and analysis of how the Raven Small UAV (SUAV) is supposed to be operated and maintained according to "doctrine" as compared to how the system is actually operated and maintained in "practice." The Department of Defense's (DOD) Doctrine, Organization, Training, Material, Leadership, Personnel, and Facilities (DOTML-PF) model is the framework used to conduct the comparison and provide in-depth analysis for each DOTML-PF component.

First, a brief overview of critical points in Chapter IV and V will be provided. Then, the focus will shift to comparing and contrasting those two chapters to form a conclusion and recommendations which will be provided in Chapter VII. The two primary issues addressed in this chapter are: 1) The Feedback Loop for lessons learned in the field to key decisions makers in garrison, and 2) What is the best way to gain key leader buy-in for the Raven SUAV? These issues were derived based on feedback from two experienced Naval Postgraduate School Faculty members.

B. DOCTRINE ANALYSIS

Analyzing DOTML-PF in doctrine from a requirements perspective as it pertains to the Raven System was a challenging and eye-opening experience. The Doctrine, Organization, Training, Material, Leadership, Personnel, and Facilities were examined based upon the current information available. Since the Raven is a fairly new system, this information and the way the Army conducts operations with regard to the Raven is in its infancy stage.

Existing written doctrine for the Raven system consists of both a Tactics, Techniques and Procedures (TTPs) manual developed at the United States Army Infantry Center and the Raven Operator's Manual. The Raven manual was developed by the manufacturer and does not include any detailed TTPs. This manual serves as an owner's manual rather than a doctrinal guide for employment. As combat operations in

Afghanistan and Iraq continue, the Infantry Center will continue to collect data and refine doctrinal manuals for the Raven SUAV. Until the doctrine is thoroughly evaluated, the Army will not know if it is written correctly. The TTPs are being evaluated on a daily basis by the Raven users in Iraq.

The key link between the user and Doctrine developers continues to evolve. As each unit employs the Raven, they will find better ways to use it, ranging from a surveillance vehicle to a noise producer to entice the enemy out of hiding. This information needs to be documented, organized, and captured so it can be disseminated to better train the warfighter in the future. The doctrinal support for the Raven is still undergoing revisions based upon the information received from the field. That information is valuable and will change the current doctrine of how we look at UAV requirements in support of DOTLM-PF.

C. PRACTICE ANALYSIS

The Raven SUAV has undergone a tremendous evolution as it has become the Army's SUAV of choice in Afghanistan and Iraq. Since the Raven SUAV was initially acquired as a Commercial Item, much of its use by deployed units has become the standard by which other units operate this system. Although there are existing Raven SUAV manuals and Tactics Technique and Procedures (TTP), units operating the Raven are finding creative ways to employ the system, thus making it a more diversified asset for maneuver commanders.

In addition to the maneuver commanders, the Raven SUAV is swiftly winning the confidence of the leadership throughout the Army. COLONEL John Burke, Project Manager for Unmanned Aerial Vehicles, stated in Army Magazine, "I really believe that the infusion of the small UAV into the Army is every bit as transformational as night vision goggles were. We're giving those tactical commanders something just as significant as night vision goggles, because we're opening up a whole new dimension of combat operations."

The new dimension of combat operations COLONEL John Burke spoke about is approached differently among maneuver commanders. COLONEL Burke added, "If a commander is in urban operations, he's going to use it for urban ops. If a commander is out at a firebase, he's going to use it for firebase security. He's going to use that system to plug a gap that he needs some kind of surveillance over. What we find is that every commander will use it differently because they have different missions, different terrain, different populations, and different competencies. The point is that the commander is going to use it to the limits of his creativity in the context of his environment and his mission."

These differences in Raven SUAV usage form the dichotomies among doctrine and practice with regard to the system. Section D of this chapter provides analysis on each component of DOTML-PF comparing doctrine to practice in order to highlight potential dichotomies.

D. DOTML-PF COMPARISON

1. Doctrine

Doctrine is the component of DOTML-PF that is most significant when comparing "Doctrine" to "Practice" regarding Raven SUAV operations. Doctrinal uses of the Raven SUAV listed in the Raven Techniques, Tactics, and Procedures (TTP) Manual dated 26 June 2004 are:

1.) Using Raven to draw out enemy forces.

2.) Conducting Convoy Security missions.

3.) Conducting Counter-Mortar Quick Reaction Force Operations.

4.) Conducting Air-Ground Teaming Missions.

5.) Conducting Area Reconnaissance missions.

Units operating the Raven SUAV in Afghanistan and Iraq conduct most of the doctrinal missions listed in the Raven TTP Manual, but with differences in execution.

These units also use the Raven SUAV for missions not listed in the Raven TTP manual. These additional missions are highlighted later in this chapter.

Using the Raven SUAV to draw out enemy forces is a mission not conducted by forces operating in Afghanistan and Iraq. This particular mission uses the Raven to determine enemy positions or differentiate combatants from non-combatants. According to the TTP manual, units fly the Raven SUAV over the selected enemy positions repeatedly at low altitude and high speed in an attempt to attract the attention of enemy forces. Once in the open, an established Sniper Team or Armed Aircraft destroys the enemy troops. This mission is purely doctrinal in nature and is not reflected in the known "practices" of deployed units.

When employed in a Convoy Security role, the Raven SUAV can be used to search for suspicious activity, scout ahead to positively identify turn points, locate potential choke points, and maintain integrity of the convoy, etc. [Ref. 5] The Raven SUAV TTP Manual does not provide specifics with regard to executing the Convoy Security mission; however, it does caution Raven SUAV operators to check for obstructions in flight path (overpasses, wires, signs, roadside vegetation, oncoming traffic, etc.) prior to launching the mission.

Units operating the Raven SUAV in Afghanistan and Iraq use the system on a daily basis to conduct Convoy Security missions. One unit briefed that the unit's Ravens are normally employed by the maneuver company, but that in some cases it is employed to protect the logistics supply trains. In this particular unit, the Raven SUAV's popularity presented asset allocation issues in that it was the only asset providing situational awareness to maneuver commanders, while the unit's support assets also required its usage for convoy security during logistics support missions. Unit commanders confronting these type issues quickly realized how important the Raven SUAV was to all facets of combat operations.

According to the Raven SUAV TTP Manual, the system is also used to conduct Counter-Mortar Quick Reaction Force (QRF) Operations. If mortar activity is suspected or detected, the Restricted Operation Zone (ROZ) is immediately activated. A Raven

team acts as a QRF, ready to immediately launch during the expected window of enemy mortar activity. If a target is located, the Raven team records the activity using the digital video camera and provides target information via spot report. [Ref. 5] When executed as described in the TTP Manual, use of the Raven SUAV for this mission has proven to be effective in mitigating enemy mortar fire.

Deployed units operating the Raven SUAV to conduct Counter-Mortar QRF Operations execute their missions in a manner similar to what is described in the TTP manual. The system is predominately at the maneuver company level and operated in conjunction with QRF operations. They monitor Anti-Iraqi Forces (AIF) activity and conduct raids on insurgent strongholds and hideouts. Raven operators typically launch and recover the system from building rooftops and water towers in order to maintain the best possible Line of Site (LOS). Raven teams are accompanied by a Radio Transmitter Operator (RTO) and squad-sized security force when operating outside their Forward Operating Base (FOB). [Ref. 9]

Air-Ground Teaming is a doctrinal mission found in the TTP manual and habitually conducted by deployed units. When employed as a team, the Raven operator can identify a target, and the ground team can rapidly move to the location and make a clear assessment of whether or not the target is a threat. [Ref. 9] Once identified as a threat, the target can be destroyed while the Raven continues executing subsequent missions. This use of the Raven SUAV is popular for deployed units as it allows commanders to have continuous situational awareness in their area of operations.

Chief Warrant Officer 3 Steve Schisler, Raven Integration and Customer Service Officer, explained in an interview conducted on 17 February 2005 that the Raven is best employed in conjunction with ground forces. “If you have guys doing a mounted or dismounted patrol in a city or a small town, you can have the Raven flying overhead providing far-sight security. The patrol can't see past the building 100 meters in front of them, but the Raven can. The Raven can see beyond the building to where terrorists with their AK-47s are running to engage the patrol. The Soldiers can then respond to the intelligence rather than respond to an attack."

The final doctrinal Raven SUAV mission listed in the TTP manual is Conducting Area Reconnaissance. Although there are no specific instructions in the TTP manual on how to execute the area reconnaissance mission, units operating the system in Iraq and Afghanistan have established such procedures. The Raven is incorporated into the unit's mission planning and used to conduct the leader's reconnaissance to develop target books for future missions. Platoon leaders monitor handheld Remote Video Terminals (RVT) before entering buildings during "snatch and grab" missions, and while maneuvering through hostile city streets. Raven operators have become so well acquainted with the area of operations that they can fly into areas without checking maps or entering waypoints. [Ref. 9] The operator's overwhelming proficiency in operating the Raven SUAV can be attributed to their execution of numerous area reconnaissance missions.

Doctrinal missions written in the TTP Manual for the Raven SUAV are similarly executed by units operating in Afghanistan and Iraq with a few modifications. Commanders in the field are finding new ways to operate the system to fit the needs of the unit and thus further expanding the capabilities of the system. The critical aspect of their creativity is getting that new doctrinal information back to those who write, update, and publish doctrine for the system. This is known as the feedback loop between commanders in the field and doctrine writers at Training and Doctrine Command (TRADOC).

The feedback loop for the Raven SUAV remains a work-in-progress as a result of its newness to the Army community. The current process for getting feedback information from the field varies significantly. In some cases an Operational Assessment (OA) team will travel to theatre to collect information, and then report it to the Department of the Army and TRADOC. On other occasions a Center or School House will do an independent survey either during or after a rotation by a certain unit. Usually those surveys are After Action Reports conducted shortly after a unit has returned. Those surveys are gathered, a report is written, and then forwarded to United States Army Test and Evaluation Command (ATEC), United States Army Research Laboratory (ARL), and Human Research and Engineering Directorate (HRED) for recording and dissemination. Information is gathered from all the reports and usually sent to the Center for Army

Lessons Learned (CALL) for dissemination. At the same time, Doctrine developers are collecting information, verifying it, and implementing it into current doctrine manuals. In some cases, manuals are needed and are developed through the proponent with input from user schools and centers.

2. Organization

There is a definite disparity between doctrine and practice in the Organization component of DOTML-PF. According to doctrine, the Raven SUAV is to be operated below company level and divided among the platoons. The requirement is for one soldier to operate and maintain the system while deployed in support of combat operations. Per doctrine, certain components of the system require higher level maintenance support. COLONEL John Burke, U.S. Army Project Manager, UAV Systems, stated "I now have something as a company commander to give me three-dimensional situational awareness; I never had that as an asset of my own before." This statement drives home the point of where key leaders see the Raven most effectively owned, operated, and maintained.

In practice, the Raven SUAV is owned, operated, and maintained at four different levels within the Army that range from brigade to platoon. Once the sole domain of brigade commanders and above, the hand-launched Raven is now in the hands of platoon leaders and company commanders. Commanders at each of these four levels use the system for varying missions and have each achieved their respective successes. Although there are different schools of thought concerning which level at which the Raven SUAV should be owned, operated; and maintained; the one common theme across the board is that the system is beneficial to commanders at all levels.

3. Training

As discussed in Chapter IV, the methodology for training on the Raven SUAV is not written; however, there is a solid plan established to prepare units to deploy and effectively operate the system. AAI, a leading manufacturer and provider of support services for unmanned aerial vehicle (UAV) systems, is the agency contracted to train U.S. Army soldiers on how to operate the Raven UAV system. The contract provides in theater training for Raven systems that are to be operated by deployed U.S. Army soldiers. AAI delivers a series of 10-day “school house” training courses staffed by 11

instructors and support personnel. [Ref. 16] The specific aspects and phases of Raven SUAV training is discussed in Chapter V.

The critical point of focus for the Training component of DOTML-PF is that the valuable training provided in the field by AAI should be incorporated into the feedback loop for lessons learned. At some point, Non-commissioned Officers within the Army should become the proponent for Raven SUAV training as it will provide a substantial savings to the government and ultimately that individual unit. Conducting in-house training will also mitigate many of the issues soldiers on the ground have encountered while operating the system. In an interview with a soldier operating the Raven SUAV in Iraq he said, "The training I received in Kuwait was alright but it was too easy to fly there because of the wide open area." The soldier also stated that the training in Kuwait did not prepare him for operating the system with limited LOS and a confined launch and recovery site.

The Army's philosophy of "Train as you fight" is not conducted in totality with the Raven primarily because of the newness of the system. The training issues discovered during the independent user assessment validates the need for more realistic training scenarios with an emphasis on information provided from the feedback loop. This will increase soldier confidence in operating the system and maximize the Raven's mission success rate.

4. Material

The current material solution for the Army's SUAV requirement is the Raven which fits closely into the Class II description for the Future Combat Systems (FCS). According to the Department of the Army Unmanned Aerial Vehicle Systems (UAVS) Roadmap, the Class II UAV is controlled and operated at the company level and serves to provide reconnaissance, security/early warning, target acquisition, and designation for the Infantry Company in support of enemy engagements. [Ref. 12] Although the Raven was initially a Commercial Item Acquisition, the system continues to exceed key leader standards and formal SUAV requirements.

5. Leadership

Key Leader buy-in is a critical part of a successful SUAV program. One of the key ways leader buy-in is being established is by the Project Manager for Army Unmanned Aerial Vehicles Systems and the Infantry Center traveling to the Divisions and briefing the key leaders prior to their deployment. The briefing given to the Divisional Leadership is called a New Material Introductory Brief (NMIB). This briefing informs the leadership of the Raven SUAV capabilities and limitations. It also contains information that the leadership needs to know about the Raven. Some of the key areas of the brief are the system description, system employment, mission overview, data capture / transfer, and training. If there is no time prior to deployment to present this briefing, the PM office and an Infantry DCD representative will travel into theater to conduct this briefing. The benefits of this briefing are remarkable so far. The leadership is amazed with the capabilities that this system can provide when properly employed. Major Chris Brown, Kuwait Raven Equipping Detachment officer in charge stated:

> The system is developing the confidence of the leadership. We had one commander's team find an IED (improvised explosive device) on its first mission, and the commander has been sold ever since. The Raven flies various missions that aid in force protection. It is flown to search for IEDs, provide reconnaissance for patrols and flies the perimeter of camps.

Chief Warrant Officer 3 Steve Schisler supported Major Brown's comment by adding:

> When a company or battalion can't get the larger UAV, such as the Hunter, Shadow, and Inet, the Raven works very well," said Chief Warrant Officer 3 Steve Schisler, Raven integration and customer service officer.

As the success of the Raven continues, the desire and need for it will increase. This asset will greatly influence the way the Army leadership at the lower levels conducts combat operations.

6. Personnel

Currently there is not a dedicated operator for the Raven. It has been someone that has good hand-eye coordination and is also highly motivated. Or in the case of the Special Forces teams it is whoever has a need for the Raven. In the Infantry unit it is

assigned to a soldier and he employs it as the commander orders, based upon operational needs. At this time there is not a particular MOS or a skills identifier attached with this weapon system. Major Chris Brown, Kuwait Raven Equipping Detachment officer in charge stated:

> The Raven is not MOS-specific, but rather the question is who can the unit use? One example Brown gave was the food service specialists in Iraq have a smaller role because the food services are contracted to Kellogg, Brown, and Root. One of the best pilots in the 1st Cav. is a cook, but that doesn't mean we don't have scouts operating the Raven. Some of these kids have been raised with Play station in their hands and are better able to handle watching a screen and controlling the aircraft.

Colonel John Burke, Project Manager, Unmanned Aerial Vehicle System, added the following regarding Raven SUAV military occupational specialties:

> It's all done in theater. The only thing we do in the States is procure the equipment. We ship it to a training base in Kuwait and the soldiers are trained right there at the training base in Kuwait with about a two week program of instruction. We've trained 44 different MOSs (military occupational specialties), from Apache pilots to cooks. It's a very command-oriented system. We give them real proficiency in how to operate the system but what we find is that the commanders are going to use that system to meet whatever mission they have.

UAV operations were not a part of regular operations for TF 1-7 prior to deploying in support of Operation Iraqi Freedom 2. This unit was originally trained and equipped as a direct support Field Artillery battalion before deployment. The battalion transitioned to operating like the infantry, as a maneuver task force under the First Infantry Division's 2nd Brigade Combat Team. Raven operators were selected from within the task force and sent to Kuwait for UAV training. [Ref 13] The training they received was taught by other military and contractor personnel.

One great Raven SUAV success story was with a Texas National Guard Unit. The unit was the 56th Brigade Combat Team, 36th Infantry Division. They were station in Baghdad, Iraq, providing security prior to the first elections in March 2005. They were the first unit in the Texas Army National Guard to acquire and field the SUAV in a

combat mission. The Air Force requested them to fly the Raven over the air base to look for possible threats that might be in the area.

Prior to coming to Iraq, most of these Infantry soldiers never heard of a SUAV or what the acronym stood for. The soldiers were given their first mission to conduct reconnaissance within their area of operation. Until now, most of the soldiers to include the high ranking leadership within the organization, doubted the benefits of using the Raven SUAV. Some of the soldiers referred to SUAV as a toy and a model Airplane. This aircraft is far from being a toy because the job it performs is just as deadly as the attack helicopters that fly in the airspace of Iraq and because the information that it collects can tell ground troops where the enemy or threat is located. [Ref 14]. Soldiers have learned that the Raven can be used to perform other missions as well. They also use it for force protection, route reconnaissance, target acquisition, and battle damage assessment.

A Sergeant in the aforementioned unit stated that the SUAV is an invaluable intelligence-gathering tool and that the real-time imagery the Raven provides is invaluable. He stated, "By employing the Raven with these units, fewer Soldiers are put at risk in doing the observation job that the Raven is capable of doing for them and is definitely a life saver." [Ref. 14]. The operators of the Raven SUAV in the case of the Texas National Guard are actual Intelligence analysts. In most cases within the Army, the operator is the Infantry soldier on the ground. When this is the case, the Infantry Soldier is no longer a shooter.

7. Facilities

There are no real facilities involved with the requirements generation, maintenance, training, or support for the Raven SUAV. The only facilities that are involved are where the system is manufactured in southern California. Since the Raven is a hand-launched UAV, there is no requirement for an airfield. Figure 6 shows a soldier hand-launching the Raven SUAV for an undisclosed mission. His unit is employing the Raven in a three-soldier team. This enables for the Raven to be set up and ready to launch within ten minutes with no facility requirement. [Ref 15]

Figure 6. Raven SUAV Hand Launch [Ref 15]

E. CHAPTER SUMMARY

This chapter provided a discussion and analysis of how the Raven Small UAV (SUAV) is supposed to be operated and maintained according to "doctrine," as compared to how the system is operated and maintained in "practice." The Department of Defense's (DOD) Doctrine, Organization, Training, Material, Leadership, Personnel, and Facilities (DOTML-PF) model is the framework that was used to conduct the comparison and provide in-depth analysis for each DOTML-PF component.

The brief review of Chapter IV and V was provided in order to provide the reader a clear understanding on the intent of this chapter. The focus then shifted to comparing and contrasting those two chapters to form a conclusion and recommendations which will be provided in Chapter VII.

The two primary issues addressed in this chapter were The Feedback Loop and the best way to gain leader buy-in for the use of the Raven SUAV. These two issues play a leading role in the overall success of the Raven. Without either one of these key elements, the system will not be a success. The Feedback Loop is critical in gaining information from the field and establishing doctrine based upon the lessons learned. Without a solid Feedback Loop, soldiers will have to start from scratch each time they employ the system, wasting valuable time to relearn the system's capabilities.

Key leader buy-in is gradually occurring with each successful mission flown by the Raven. The PM office, in conjunction with the Infantry Center, has coordinated with the Units in Iraq and in CONUS to give them the NMIB. This briefing is the first step in establishing key leader buy-in and support. The briefings are going well and the leadership is seriously interested in exploiting the value that the Raven brings to operational missions.

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VII. FINDINGS AND RECOMMENDATIONS

This chapter examines the primary and subsidiary research questions. Conclusions and recommendations are presented as well as recommendations for further research.

A. PRIMARY RESEARCH QUESTION

Are there differences between doctrine and practice with regard to Raven SUAV operations?

Overall, doctrine and practice differ for Raven SUAV operations. The primary cause is that Raven was initially acquired as a commercial item with minimal written doctrine accompanying it. Since its acquisition, Raven has evolved into the Army's SUAV of choice and doctrine continues to improve as units find new and innovative ways to employ the system.

Using the Department of Defense's (DOD) Doctrine, Organization, Training, Material, Leadership, Personnel, and Facilities (DOTML-PF) as our framework for comparing doctrine to practice, we discovered that Doctrine, Organization, and Training were the components in which differences exist. Based upon our analysis it is our conclusion that although differences exist between doctrine and practice, there are none that are mission-threatening. In fact, commanders have found ways to use the system that have saved numerous lives. The critical issue however is how these uses are incorporated into future doctrine. This portion of the primary research question is answered by the responses to subsidiary questions one and two. The conclusions to these research questions and accompanying recommendations are presented below.

B. FIRST SUBSIDIARY QUESTION

Is there an efficient and effective feedback loop for Raven SUAV lessons learned?

1. Conclusion

There is no standard feedback loop established for incorporating Raven SUAV lessons learned from the field into doctrine. The current process for getting feedback information from the field varies and spans two different methodologies. The first and most popular method consists of an Operational Assessment (OA) team collecting data observed while in theater. The OA team also conducts interviews with key leaders and Raven operators to ensure that what is observed is cross-checked with input and feedback from unit personnel. The information is then reported to the Department of the Army and Training and Doctrine Command (TRADOC).

The second method for incorporating Raven SUAV lessons learned in the field into doctrine consists of a Center or School House representative conducting an independent survey, either during or after a specific unit rotation. In most cases, these surveys are After Action Reports conducted shortly after a unit has returned. Surveys are gathered, a report is written, and then forwarded for recording and dissemination.

There have been no reports concerning which methodology is more effective however information and lessons learned from units operating the system are properly written into doctrinal manuals for the Raven SUAV. Although not standard, both of these methodologies can serve as interim feedback mechanisms Standard Operating Procedures (SOP) are established.

2. Recommendations

Decision makers should establish one standard mechanism for reporting Raven SUAV lessons learned for incorporation into evolving doctrine. Many success stories have been told about Raven and how it is saving lives on the battlefield. How these units employ the system is perishable feedback data that must be effectively and efficiently synthesized and disseminated. Units should not wait until redeployment to disseminate Raven SUAV lessons learned, but rather do so as soon as they discover new and

innovative ways that preserve life and increase combat effectiveness. Figure 7 depicts the author's recommended diagram of how lessons learned are incorporated into doctrine and disseminated.

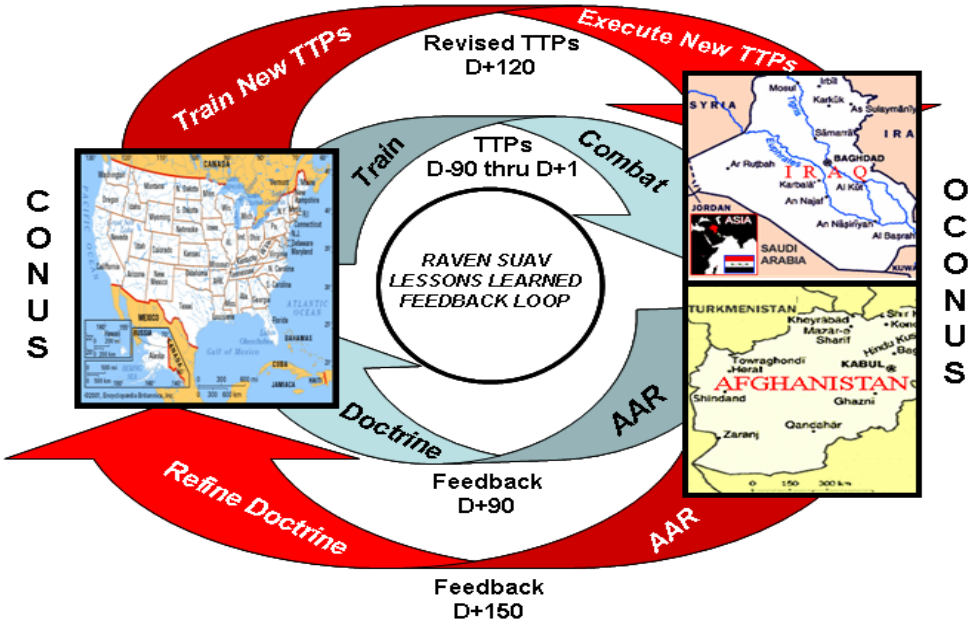

Figure 7. Recommended Raven SUAV Feedback Loop [Ref. 16]

C. SECOND SUBSIDIARY QUESTION

Are "real-world" lessons learned systematically incorporated into Raven SUAV doctrine?

1. Conclusion

The Raven SUAV is a new and unique system which has been available to the warfighters only since mid 2003. Small UAVs have been flown by the Marine Corps as well as the Army Special Operation Forces, but there is no systemic documentation of the "real world" lessons learned.

Since the Raven is a new system and falls under the Rapid Equipping/Fielding in support of OIF and Operations in Afghanistan, everything that is done is experimental and "learn as you go." The lessons learned from operations in Iraq are documented and are help develop doctrine and procedures for future forces. The Infantry Directorate of

Combat Development (DCD) is closely monitoring how the various units in Iraq are best employing the system. They are then able to document the best procedures and practices. encompassassing many ways to employ the Raven.

The Infantry Center DCD is providing excellent documentation about how the Raven is employed. The subject matter experts at the Infantry Center are Mr. Reggie Poissant and Major Matt England. They have traveled to Iraq to ensure that employment are being employed are being recorded and included in appropriate documents. These same individuals will also be on the Integrated Product Teams (IPT) that will develop SUAV requirements in the future. They will take the lessons learned and put them to use in developing future requirements and TTPs.

2. Recommendations

The Infantry Center DCD is doing an excellent job gathering information from the field. They should continue gathering this information from soldiers in deployed and returning units. This information should be systematically documented and sent to the Center for Army Lessons Learned (CALL). The CALL has a classified website that is used extensively for discussing current TTPs for both Blue and Red forces. Commanders in the field will be alerted to go to the CALL website to get relevant and current information that's relevant and up-to-date. Due to the CALL being at Ft. Leavenworth, the Combined Arms Center and Combined Arms Directorate can ensure they stay in the loop. The Army Airspace Command and Control (A2C2) system, developed by the Infantry Center DCD was put on the CALL website. Commanders were sent an email to download it, and now all SUAV users in Iraq can use the guide to help deconflict airspace. The unclassified CALL website is http://call.army.mil/thesaurus.htm.

D. THIRD SUBSIDIARY QUESTION

How is PM-UAV/Army achieving leader buy-in for the Raven SUAV?

1. Conclusion

Leader acceptance of the Raven SUAV was recognized early by the Project Manager's office as being one of the most important issues for system success. Since it is not a fully funded Army program and the requirements came from the commanders in the field, the PM concluded that buy-in was therefore significant. Some commanders immediately used the Raven to its full potential. Others saw it as a hindrance which took away from their ground combat power, seeing Raven as more like a toy than a combat multiplier. As lessons learned from Raven success came out of the field and were analyzed by the PM and the Infantry Center DCD, new TTPs were developed. Due to the lack of buy-in by various commanders at all levels; a briefing was designed solely for educating leadership on the benefits of using the Raven. This initiative has been a great success, and leadership gradually grasps Raven capabilities.

2. Recommendation

The PM office should continue doing what they are doing. Having proactive Product Managers is crucial to the success of this system. They are able to observe and educate the leadership about the significance of Raven. They must also include staff members from all levels within the organization. In doing so, the leadership must emphasize the importance of the Raven and how it should be employed based upon current TTPs. The PM office must gain input from senior leaders, action officers, commanders, and soldiers concerning the functionality of the Raven. Since the Raven impacts all aspects of unit missions and there currently is not a dedicated system operator, more than one person needs to be able to effectively operate and maintain the system.

Securing leader buy-in is not an easy task. With each successful mission leadership gains trust in Raven capabilities. As Mark Walton states in his book Generating Buy-In, there is a step-by step-process that must be used in order to get leadership, organizations, and soldiers to accept new systems or practices. Walton also

states that, “Generating buy-in is an indispensable resource for leading and succeeding in today’s fiercely competitive world.”

E. AREAS FOR FURTHER STUDY

1. Conduct an analysis to determine why the Army chose to acquire the Raven versus the Dragon Eye which was already in use by the Marine Corps.

2. Conduct an analysis to determine if the Raven SUAV can or will evolve into the Future Combat Systems (FCS) SUAV of choice.

3. Conduct research to determine if the author’s recommended feedback diagram (Figure7) is a feasible mechanism for capturing, incorporating and disseminating lessons learned.

APPENDIX A. TRIP REPORTS

A. LAS VEGAS, NEVADA

NPS 10 Jan 2005

MEMORANDUM FOR RECORD

SUBJECT: TRIP REPORT –UAV Conference, Las Vegas, NV, 8-9 November 2004

PURPOSE: To document results of thesis research findings while attending the UAV Conference in Las Vegas, Nevada.

DISCUSSION:

1. This conference focused upon the UAV technologies that are being developed and fielded as a response to DoD's transformational goal for integrating unmanned aircraft into the current and future warfighting force. The DoD's demand for UAVs has never been greater as billions of dollars continue to pour into UAV research, development, testing, and training. UAVs have continued to exceed expectations as a front-line ISR aircraft in Iraq and Afghanistan, and will soon take on other attack missions deemed too dangerous for human undertaking. As a critical component in network-centric warfare, emerging UAV payload opportunities should magnify their roles and responsibilities tenfold. The development of new UAV technologies to support future missions and initiatives leaves the door wide open for industry to solve daunting technical challenges and capitalize upon a vast new array of developmental opportunities. The conference looked at what role various organizations will play.

The conference was sponsored by The American Institute of Engineers (AIE), the National Military Intelligence Association (NMIA), and the Association of Naval Aviation (ANA). The agenda examined the broad range of UAV platforms, missions, and payload opportunities. Some of the questions that were addressed were:

What is the OSD master plan for UAVs?

What are the Services' roadmaps for UAVs?

What is the status and likely future direction for the Global Hawk, Predator, X-45, X-47, Fire Scout, and numerous other UAV platforms?

Where are the Service challenges, needs, and initiatives in arming UAVs?

Where are the payload opportunities associated with Global Hawk, Predator, Shadow, UCAR, and other major platforms?

2. This was a very beneficial trip. This was our initial meeting with our sponsor, COL John Burke, the Project Manager for the Army Unmanned Aerial Vehicle Systems (UAVS) UAV program. He gave us his input and assisted us in narrowing the scope of our thesis. We came out of the meeting with an initial rescoped question of "Is it feasible to have UAVs below battalion level." This was the question we went with and then narrowed the topic from there to come up with current Thesis Question. There were many representatives from Government and Industry attending this conference. This enabled us to make contact with Chris Hernandez, Vice President, Northrop Grumman, and arrange a meeting with them at a later date.

3. Point of contact is MAJ William Snodgrass at wjsnodgr@nps.edu.

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B. SAN DIEGO, CALIFORNIA

NPS 28 Jan 2005

MEMORANDUM FOR RECORD

SUBJECT: TRIP REPORT – Thesis Research Travel to San Diego (13-14 Jan 2005).

PURPOSE: To document results of thesis research findings and results while attending meetings with Sparta Inc. Composite Products Operations and Northrop Grumman

DISCUSSION:

1. Our meeting with at Sparta Inc. convened on 14 January 2005 at 0900. The purpose of the meeting was to identify current and emerging Small Unmanned Aerial Vehicle (UAV) developments and technologies to support units below the battalion level. The facilitator of this meeting was Mr. Sonny Haskins, Director, UAV Projects, SPARTA, Inc.

2. Mr. Haskins started the meeting by providing us with an overview of Sparta's mission, role, and objectives with regard to developing technologies and explained that the meeting would remain unclassified. With this background, we discussed the history of the small UAV system as well as other tasks that SPARTA performed to support the warfighter.

3. Mr. Haskins then provided us with a thorough briefing on Sparta's role in the development of the Raven UAV which is currently being extensively used in Iraq and Afghanistan. Sparta is responsible for producing the wings, the centerpiece, and the nose cone for the system. The only portion of the Raven system that Sparta does not produce is the fuselage. Further discussion focused on Raven supportability and maintainability.

4. Mr. Haskins then provided us with an extensive tour of the Sparta facilities to include the administrative and operations sections. We had the awesome opportunity to see first-hand how the parts for the Raven were made as well as other projects the company is responsible for producing. The tour of the facilities allowed us to see a real-world production line. This helped us fully understand what we learned in the classroom environment just one quarter ago.

5. Mr. Haskins concluded the meeting by answering specific questions we had regarding the Raven system. Our meeting with Sparta Inc. adjourned at 1200 hrs.3. Our afternoon meeting was with Northrop Grumman were we met with Mr. Chris Hernandez and his staff. This meeting was set up during our trip to Las Vega after we requested a copy of Mr. Hernandez's briefing slides and notes. Mr. Hernandez's staff briefed several of their current programs but did not give us much information beneficial to our thesis; however it was a good opportunity to see their facility and how they conduct business. Members of the Northup Grumman staff asked us questions regarding current Army requirements and the Army UAV Way-ahead document. We informed them that we were not aware of current requirements and the Army Way ahead. We reiterated that we were students and did not represent the Army UAV Program Office. The meeting adjourned at 1600.

6. Point of contact is MAJ Glenn Jenkins at gejenki@nps.edu.

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C. SAVANNAH, GEORGIA

NPS 06 Feb 2005

MEMORANDUM FOR RECORD

SUBJECT: TRIP REPORT –UAV Fielding and Sustainment Integrated Project Team (FSIPT) Savannah GA, 31 Jan - 4 Feb 2005

PURPOSE: To document results of thesis research findings while attending the FSIPT in Savannah, GA

DISCUSSION:

1. This conference focused on UAV sustainment and fielding within the Army. The first day consisted of briefings regarding was taking place in theater and the fielding process for the Army UAV systems. This focused primarily upon the big picture. The attendees consisted of people from the Project Office, the Infantry Center Directorate of Combat Development (DCD), the TRADOC System Manager (TSM), the contractors that support the various systems, and the user representatives from the units.

2. COL Burke had opening remarks and began his briefing by asking the audience "What is a Project Manager"? He explained the roles and responsibilities of the Project Manager (PM) and where he fits into the big picture of the Army UAV Acquisition Strategy. He did not focus primarily upon one particular UAV System, but looked at the future of UAVs.

3. On day two and three, the IPT broke out into Splinter Groups. We were part of the Small UAV/Raven group which was headed by the Assistant PM for UAVs, LTC Andy Ramsey. Other members in the group were from Army Headquarters G8, Army Headquarters G3 User Representative from the ground units in the field, TSM Representative, DCD Representative from the Infantry Center, and a representative from Director, Operational Test and Evaluation.

4. We spent a majority of our time working with Reggie Poissant. Reggie is the representative from the Ft Benning DCD and wrote the SUAV Capabilities Development Document (CDD). He directly interacts with the users and spent 30 days in Iraq working closely with the units that were employing the Small UAV Raven System. He has developed the Tactics, Techniques, and Procedures (TTPs), the System Training Plan (STRAP), and the Operational Mode Summary Mission Profile (OMS-MP). We will continue to work with Reggie Poissant throughout the research for this project.

5. Point of contact is MAJ Bill Snodgrass at wjsnodgr@nps.edu.

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D. WASHINGTON, D.C

NPS 14 March 2005

MEMORANDUM FOR RECORD

SUBJECT: Trip Report–Unmanned Aerial Vehicles (UAV) Conference, Washington D.C., 06-09 March 2005

PURPOSE: To document results of thesis research findings while attending the UAV Conference in Washington, D.C.

DISCUSSION:

1. This conference featured top experts from the United States Congress, Northrop Grumman, General Atomics, Lockheed Martin, and several other agencies to examine the latest UAV opportunities from a congressional, military and industry perspective. The most important feature of the conference from a research standpoint was the UAV system updates for the Raven, Predator, Global Hawk, Fire Scout, and the Micro UAVs. These updates provided critical insight on current system usage, capabilities, and future system improvements and upgrades. This conference was sponsored by The American Institute of Engineers (AIE), in conjunction with The National Military Intelligence Association (NMIA) and the Association of Naval Aviation (ANA).

2. Congressman Jerry Lewis was the opening speaker at the conference. He explained his interest in the future of Unmanned Vehicles after highlighting its current usage and net worth to war-fighters on the battlefield in Afghanistan and Iraq. More importantly, Congressman Lewis pledged to be an avid supporter of future UAV Research and Development to ensure adequate funding at all stages of the Acquisition Lifecycle.

3. Colonel John Burke, PM UAV-Army, provided an extensive UAV Systems program update encompassing all classes of UAVs.

4. Mr. John Grabowsky, President and General Manager of AeroVironment SUAV Products Division, provided an outstanding briefing themed "Back to Iraq: Raven, Dragon Eye, & Pointer UAVs." His briefing highlighted the swift fielding and many accomplishments of the Raven, Dragon Eye and Pointer UAVs. He noted that AeroVironment delivered the first Raven SUAV to theater within 20 weeks after contract award. Mr. Grabowsky's other points of discussion during his presentation were the Raven's logistics flow, its various missions and mission success stories. Mr. Grabowsky's presentation was relevant and provided valuable information for our project research.

5. We also met with the Defense Advanced Research Projects Agency (DARPA). Dr. Brad Tousley, Program Manager for the Micro Air Vehicle (MAV) Advanced Concept Technology Demonstration (ACTD), provided extensive details about his program goals and objectives. The primary goal of the Micro Air Vehicle (MAV) Advanced Concept Technology Demonstration (ACTD) program is to further develop and integrate MAV technologies into militarily-useful and affordable back-packable systems suitable for dismounted soldier, Marine, and Special Forces missions.

6. Point of contact is MAJ Glenn Jenkins at gejenkin@nps.edu.

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